Honolulu, Hawaii

# 2009 Annual Report

## Pacific Islands Fisheries Science Center

Cover: *Fish on Fire*, gyotaku by Joseph R. McAuliffe, copyright 2008; www.ZenGyotaku.com.

Honolulu, Hawaii

# 2009 Annual Report

## Pacific Islands Fisheries Science Center

## PIFSC Mission

*To conduct high-quality, timely research to support the stewardship of fisheries resources, protected species, and ecosystems in the central and western Pacific Ocean.*

Copies of this document may be obtained by contacting:

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An online version is available at
http://www.pifsc.noaa.gov/do/index.php

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# Foreword

Samuel G. Pooley, Ph. D.
Science Director

We are happy to provide you the 2009 Annual Report of the NOAA Fisheries' Pacific Islands Fisheries Science Center. The Center's research covers a wide range of scientific issues and topics requiring expertise in many disciplines. Our principal areas of research include coral reef ecosystems; marine ecosystem analysis and oceanography; fisheries biology; bycatch mitigation; fisheries monitoring; and economic and human dimensions research; and protected species population monitoring and research. Support programs within the Center ensure success of our science endeavors by providing help with administration and infrastructure, information technology and communications, and scientific information.

In 2009, we conducted our third external review of the Center's research, this time focused on our pelagic programs—fish, cetaceans, and turtles. The review provided critical insights into areas where we need to improve and where we can develop more fully. Information on this year's review, as well as the 2007 and 2008 reviews, can be found on our Web site at: http://www.pifsc.noaa.gov/do/pifscreports.php. In 2010, we will be holding a similar review focused on our data management protocols and operations.

We have a diverse and energetic staff from a broad range of scientific and technical specialties. We engage in research expeditions year-round throughout the central and western Pacific, including American Samoa, Hawaii, the Mariana Archipelago, and remote island areas in the mid-Pacific, and maintain extensive temporary field camps at remote islands and atolls in the Northwestern Hawaiian Islands. We are committed to the highest standards of scientific research and timely conservation and management advice.

Michael P. Seki, Ph. D.
Deputy Science Director

OSCAR ELTON SETTE

# Overview of the Center

## Function and Mission

The Pacific Islands Fisheries Science Center (PIFSC) is one of six NOAA Fisheries Science Centers. It was established in 2003 with the creation of the Pacific Islands Region within NOAA Fisheries and is headquartered in Honolulu, Hawaii. The Center is responsible for research on federally managed marine fisheries, protected species such as the endangered Hawaiian monk seal and other marine mammals, and ecosystems in the entire western and central Pacific Ocean, including coral reefs, insular (near island) habitats and pelagic (open ocean) environments.

The Center's mission is to conduct timely, high quality applied science—monitoring, reporting, and analysis—to support conservation and management of living marine resources in the central and western Pacific Ocean. The PIFSC mission is linked directly to the NOAA Strategic Plan and, in particular, NOAA's Ecosystem Mission Goal:

"To protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management."

In providing science to support an ecosystems approach to the conservation, management and recovery of living marine resources, PIFSC has adopted a multidisciplinary strategy. The strategy involves integrated data collection and monitoring of marine resources and their environment, including an extensive ecosystem observation system; scientific research programs with activities focused on nearshore and pelagic fisheries, coral reef species and habitats, marine mammals and sea turtles, marine ecosystems and oceanography; and conservation and management advice directly related to domestic and international conservation and management mandates.

*Facing page: NOAA Ship Oscar Elton Sette.*

The Center's fisheries-oriented research programs monitor U.S. fisheries in the Region and conduct biological, ecological, and economic research in support of five Fishery Management Plans and four Fishery Ecosystem Plans developed by the Western Pacific Regional Fishery Management Council (WPFMC). Similar scientific contributions are made toward international management of fisheries for tuna and other highly migratory species by the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission. In both domestic and international fisheries management arenas, PIFSC provides scientific support and advice to the NOAA Fisheries Pacific Islands Regional Office (PIRO).

The Center's coral reef ecosystem research focuses on comprehensive surveys of reef ecosystems in the archipelagoes of the Pacific Islands Region. Protected species research and recovery programs monitor the status of the Hawaiian monk seal and sea turtles in the Pacific and identify the factors affecting their population, health, and recovery. A newer component of the Protected Species program is focused on surveys of cetacean populations in the central and western Pacific. Other PIFSC research investigates the structure and dynamics of central North Pacific marine ecosystems and how marine populations are affected by changes in their predators, prey, and habitat, and by ocean climate.

## History

The Center was founded in 2003 on 55 years of federal marine fisheries research dating back to the founding of the Pacific Oceanic Fishery Investigations in 1948. In 6 decades of scientific studies, Center staff and their predecessors have engaged in oceanographic research, fishery resource exploration, fisheries development, fisheries biology and ecology, and protected species recovery research and conservation throughout the Pacific and as far away as the Indian Ocean. More recently, the Center has established extensive programs in coral reef ecology through collaboration with NOAA's Coral Reef Conservation Program.

*The Dole Street office building of the PIFSC.*

| Budget by NOAA Program | | |
|---|---|---|
| | $ Million | % |
| Corals | 4.5 | 17 |
| Ecosystem assessment | 19.6 | 71 |
| Protected species | 3.4 | 12 |
| *Total* | $ 27.5 | |

| Personnel | |
|---|---|
| Federal | 96 |
| JIMAR | 116 |
| Other | 12 |
| *Total* | 224 |

## Geographic Area of Responsibility

Bounded by the Hawaiian Archipelago in the north, American Samoa and U. S. Pacific Remote Island Areas in the south, and the Mariana Archipelago in the west, the Pacific Islands Region encompasses the largest geographical area within NOAA's jurisdiction. The U.S. Exclusive Economic Zone (EEZ) within the Region includes more than 1.7 million square nautical miles of ocean, roughly equal to the total EEZ of the continental United States and Alaska. PIFSC shares responsibility for research on living marine resources in the high-seas areas of the central and western Pacific.

## Budget and Staffing History

In fiscal year (FY) 2009, the PIFSC budget was $ 27.5 M and supported a staff of 224 researchers, technical personnel, and administrative employees. Almost all of the Science Center's budget supports the NOAA ecosystems mission, and its activities generally fall within the Ecosystems Observation Program and Corals Program. In addition to federal employees, Center programs include many scientists and seasonal technical staff employed by the University of Hawaii (UH) Joint Institute for Marine and Atmospheric Research (JIMAR) and private contractors. Several UH students also work at the Center or are engaged in graduate research with Center projects, and Center scientists serve as affiliate faculty and are on graduate student committees within the university.

## Facilities and Vessels

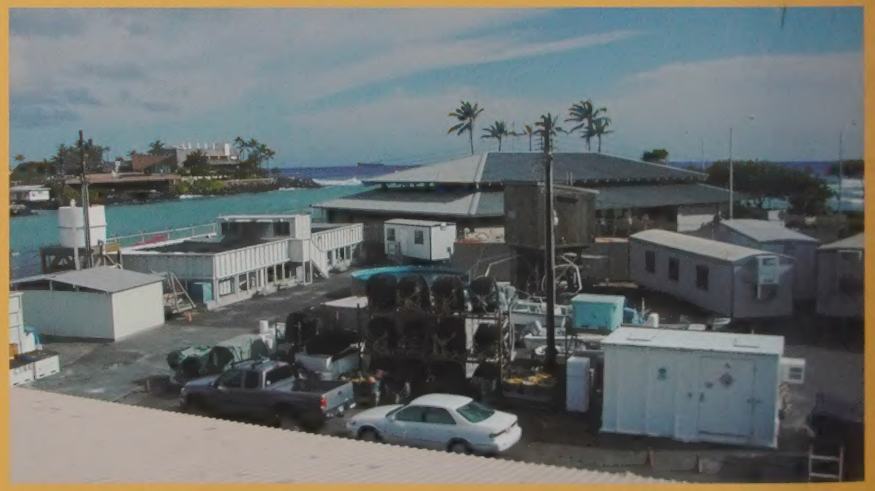
The Center is located at five sites in Honolulu; the older office complex is located on Dole Street, adjacent to the University of Hawaii at Manoa campus. A smaller seawater research facility is located at Kewalo Basin on the Honolulu waterfront, enabling research on live, large pelagic fishes, monk seals, and sea turtles. This location is also the site of most of the Center's coral reef ecosystem monitoring staff. Another research facility, with offices and a wet laboratory supporting fish biology work, is leased in Aiea near Pearl Harbor. PIFSC marine mammal, socioeconomics and coral reef researchers are located in offices adjoining the PIRO headquarters on Kapiolani Boulevard in downtown Honolulu, and PIFSC utilizes an advanced mapping facility on the UH campus. The seawater research functions are expected to move to a new NOAA facility on Ford Island in 2011, and an entire NOAA consolidation facility is expected to be completed on Ford Island in 2013.

The NOAA Ship *Oscar Elton Sette*, homeported at Ford Island in Honolulu, is the primary research vessel supporting the Science Center's extensive field activities. Center staff also conduct benthic habitat mapping and other coral reef ecosystems research aboard the NOAA Ship *Hi'ialakai* in partnership with NOAA's National Ocean Service. PIFSC also has 30 small boats, ranging from 14 to 25 ft in length, to facilitate nearshore research.

## Research Focus

PIFSC research currently focuses on several areas of high priority:

- ❒ Identifying and understanding the effects of ecosystem linkages and environmental processes on fish stocks, protected species, and other marine life and developing the scientific basis for ecosystem-oriented management
- ❒ Monitoring and reducing fishery interactions with protected species
- ❒ Monitoring the status of Hawaiian monk seals and finding ways to increase their survival and population sustainability
- ❒ Assessing the populations of deepwater snappers, groupers and jacks (bottomfish) in the main Hawaiian Islands
- ❒ Monitoring the status of marine turtle populations in the Pacific
- ❒ Assessing cetacean populations and the effects of human activity on them
- ❒ Mitigating fisheries bycatch, particularly in multinational pelagic longline fisheries
- ❒ Assessing the stocks of tunas, billfishes, sharks, and ecologically related pelagic species and providing scientific advice in



*Kewalo Research Facility.*

support of international and domestic management of fisheries that catch these species

- Researching the use of barbless circle hooks by recreational fishers to reduce post-release fish mortality and risks of injury to protected species
- Expanding the understanding of socio-economic and cultural aspects of living marine resource use and management throughout the region
- Assessing the physical and biological structure, dynamics, and health of coral reef ecosystems
- Monitoring and removing derelict fishing gear and other marine debris from reefs and nearshore waters of the Hawaiian Archipelago
- Expanding our fisheries and ecosystems monitoring and research in the waters of American Samoa, Guam, and the Northern Mariana Islands in cooperation with these jurisdictions

## Science Center Organization

In 2009, scientific work was carried out by five research divisions:

- Coral Reef Ecosystem Division (CRED)
- Ecosystems and Oceanography Division (EOD)
- Fisheries Monitoring and Socioeconomics Division (FMSD)
- Fishery Biology and Stock Assessment Division (FBSAD)
- Protected Species Division (PSD)

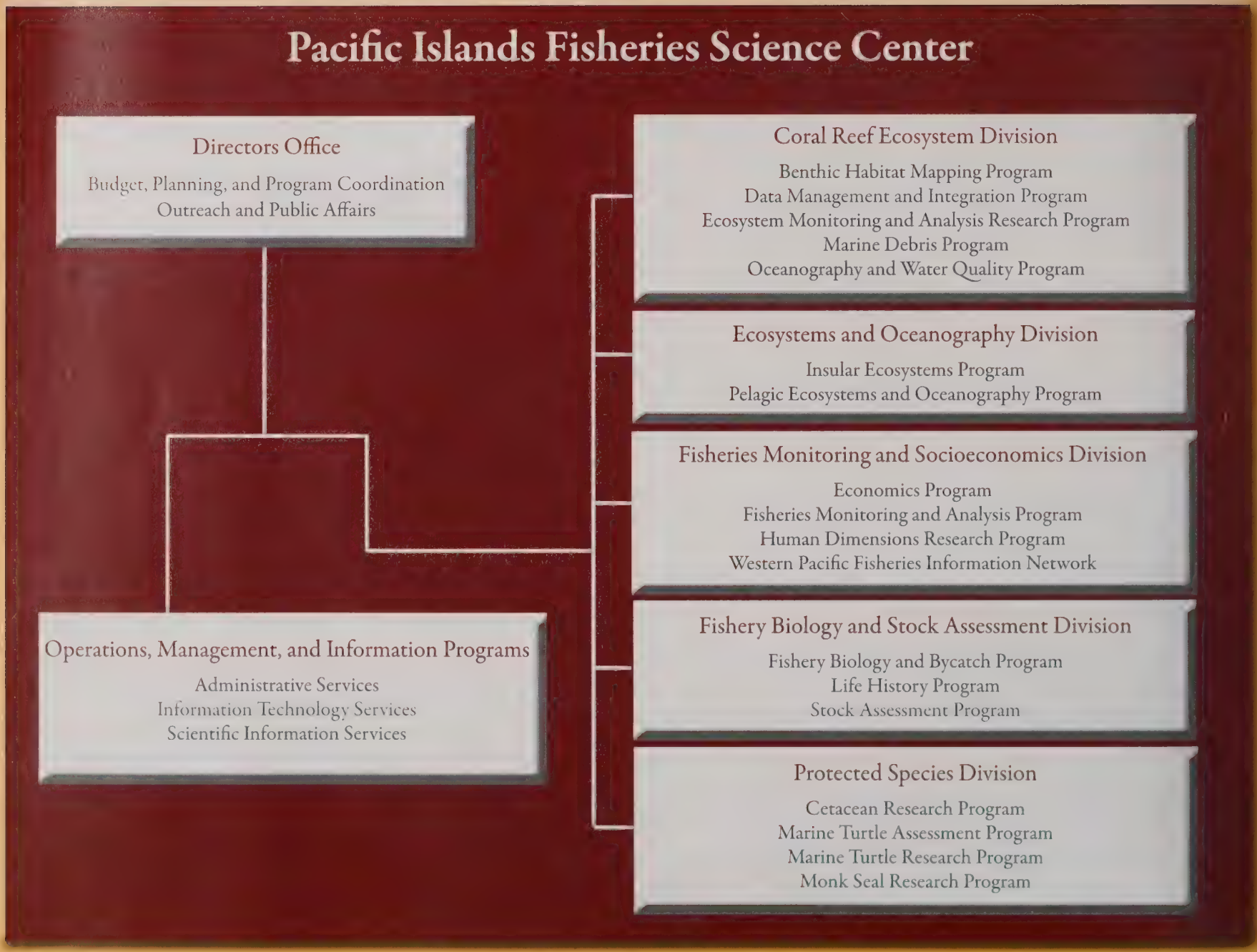
The Operations, Management, and Information (OMI) Division has three programs providing essential support across the Center:

- Administrative Services
- Information Technology Services
- Scientific Information Services

*Aiea Heights Research Facility (leased space).*

*Kapiolani Boulevard offices (leased space).*

# Pacific Islands Fisheries Science Center


Directors Office
Budget, Planning, and Program Coordination
Outreach and Public Affairs
Operations, Management, and Information Programs
Administrative Services
Information Technology Services
Scientific Information Services
Coral Reef Ecosystem Division
Benthic Habitat Mapping Program
Data Management and Integration Program
Ecosystem Monitoring and Analysis Research Program
Marine Debris Program
Oceanography and Water Quality Program
Ecosystems and Oceanography Division
Insular Ecosystems Program
Pelagic Ecosystems and Oceanography Program
Fisheries Monitoring and Socioeconomics Division
Economics Program
Fisheries Monitoring and Analysis Program
Human Dimensions Research Program
Western Pacific Fisheries Information Network
Fishery Biology and Stock Assessment Division
Fishery Biology and Bycatch Program
Life History Program
Stock Assessment Program
Protected Species Division
Cetacean Research Program
Marine Turtle Assessment Program
Marine Turtle Research Program
Monk Seal Research Program

# The Directors Office

The Directors Office provides overall scientific leadership, strategic guidance, research direction, program management, and operational policy for the Science Center. In addition, the office is responsible for liaison with our many partner agencies and offices, including the NOAA Fisheries Pacific Islands Regional Office and other NOAA offices locally and nationally; the Western Pacific Fishery Management Council; resource management agencies of American Samoa, Guam, Hawaii, and the Northern Mariana Islands; the University of Hawaii and the University of Guam; the U.S. Fish and Wildlife Service; fishing industry members and organizations; recreational fishers; nongovernmental conservation organizations; other groups and the general public. The Directors Office provides coordination and leadership for U.S. participation in international scientific committees and commissions in the Pacific. The Center Director serves on the NOAA Fisheries Science Board and is the U.S. delegate to PICES (the six- nation North Pacific Marine Science Organization). The Directors Office also manages the Center's planning and budget functions as well as outreach and public affairs.

*Excellence in all areas of Science Center work is recognized and rewarded.*

## Budget, Planning, and Program Coordination

Many Center-wide budget, planning, and program coordination activities are implemented by the Budget and Planning Office to ensure responsiveness to and consistency with the NOAA and NOAA Fisheries Strategic Plans. These activities include:

- Generation of current and projected program operating and spending plans
- Center-wide budget formulation, execution, and requests
- Development of guidelines and policies governing maintenance of the budget
- Research program oversight, coordination, and integration
- Strategic planning and input to the NOAA Program Planning and Budget Execution System
- Establishment and tracking of performance measures and milestones
- Ensuring National Environmental Policy Act compliance for PIFSC research
- Coordination of PIFSC efforts to support the Integrated Ocean Observing System
- Scheduling and coordination of NOAA research vessel and aircraft operations
- Assessing changes in PIFSC's strategic direction associated with a stabilization of funding for fisheries stock assessment and a likely increase in marine mammal funding
- Evaluating ways to enable funding for PIFSC's obligations to provide science support to international fishery management organizations

In 2010, the Center's socioeconomic program will be located in the Directors office.

## Outreach and Public Affairs

The community outreach program serves as the focus for the communication of scientific programs with the public. The objective of the program is to seek and create opportunities to inform and educate constituents about the Center's programs. This is accomplished by:

- Establishing PIFSC as a scientific information resource for the community and networking with community groups, schools, key constituents, and the general public
- Teaching young people to become stewards of the environment
- Promoting careers in ocean sciences
- Designing educational resources and helping teachers develop a science and conservation curriculum that supports the objectives of PIFSC

## *Science Outreach Program Brings Public Awareness*

Public education is an important aspect of the Center's work. NOAA Fisheries Service believes a well-informed public can make a difference and focuses education and outreach efforts on the science concepts people need to understand the ocean, our impact on it, and its impact on us. The program designs resources and implements strategies to increase communication and understanding of scientific research conducted by the Center.

During 2009, Center staff members were active in a wide range of outreach activities, including career fairs at schools, ocean-related festivals, public meetings, educational seminars, recreational fishing tournaments, science fairs, and other events.

# Operations, Management, and Information Programs

## Administrative Services

The Office of Administration provides a comprehensive range of services in support of the Pacific Islands Fisheries Science Center's mission and staff. The office manages Center hiring and personnel issues, grants, procurement and property, safety, facilities, small boats, and staff training.

Administration specialists help PIFSC announce and fill vacancies for federal positions in Center programs; manage the orderly entry of personnel to the Center's workforce, and their departure; ensure accurate and timely accounting of staff work time and attendance; and handle other personnel issues in cooperation with NOAA's Workforce Management Office. In 2009, the Center posted announcements of 19 recruitment actions resulting in 11 recruitments during the year; several other selections will be made in the first quarter of 2010.

Members of the Administration staff manage grants and cooperative agreements supporting research and related activities for protected species, coral reefs, fisheries, oceanography, aquaculture, and other areas of scientific research critical to the NOAA mission. In 2009, the Center submitted, processed and ensured obligation of all grants, totaling more than $11 million, ahead of schedule. The Center was an active partner in the Pacific Region Grants Cooperative group which sponsored grant management training, grant writing training, and the annual convention of the Council for Native Hawaiian Advancement in Honolulu.

Our procurement specialists help Center staff obtain services, supplies, and equipment they need to meet program requirements and achieve operational goals. We strive to process invoices quickly, so contractors and vendors are paid promptly, and to record transaction accounting data accurately. We monitor the Center's equipment inventory and ensure the accurate and timely accounting of all property. In 2009, the Center executed $6.4 M in procurement actions, a 28% increase over the previous year.

The Facilities Program is responsible for maintaining Center facilities and recording and reporting material deficiencies to NOAA Fisheries facility program managers. Administration staff actively monitor the condition of PIFSC facilities and coordinate with the Center's Safety Officer and Executive Officer to identify needed repairs or improvements, determine costs, and ensure proper completion of maintenance work orders. In 2009, we began or completed several key facilities improvement projects, including exterior painting of the main office building on Dole Street, installation of a new awning over the walkway at the Dole Street office building, replacement of doors at Dole Street, installation of an office trailer at Dole Street, acquisition of space at the Kapiolani Boulevard office building, and replacement of two office trailers at the Kewalo Research Facility.

The Safety and Environmental Compliance Program helps ensure that PIFSC research programs and activities are conducted in ways that minimize injuries to employees and adverse impacts on the environment, in keeping with federal rules and regulations. The program manages facility compliance inspections and safety training and promotes behavioral changes in Center staff to reduce injuries and adverse environmental impacts. In 2009, recommendations were provided to planners of the NOAA Pacific Regional Center to ensure that the design of the new NOAA campus on Ford Island, Pearl Harbor, meets safety and environmental impact standards.

The Boating Safety Program is responsible for ensuring PIFSC compliance with NOAA policies related to boats and skiffs. The program maintains an up-to-date PIFSC vessel policy, conducts boat and water safety training for Center staff, and manages the PIFSC small boat fleet. The program coordinates with Center research divisions conducting

*Regular training keeps administrative staff abreast of new agency policies, procedures, and requirements.*

boating operations and provides assistance and guidance to them on boating and safety issues. The Center continues to be a leader in the NOAA Small Boat training program, with the Center's Line Office Small Boat Officer (LOSBO) serving as west coast representative on the NOAA Small Boat Safety Board. The LOSBO also chairs a working group to determine NOAA Fisheries boat training needs and is drafting a 5-year plan to develop and implement an agency-wide boating training program. During 2009, the Boating Safety Program also conducted Surf Rescue Boat training, Advanced Coxswain training, and Motorboat Operator Certification Course training.

The PIFSC Office of Administration also coordinates and tracks training and professional development activities of Center managers and staff and provides guidance and training on equal employment opportunity matters. During 2009, the Office of Administration sponsored several activities to encourage diversity in the workplace, including participation by 20 staff members in the International Women's Conference and participation in college job fairs. PIFSC also conducted training sessions on contract administration, travel management, and personal safety awareness. The Center served as a focal point for coordination of shared training opportunities with other NOAA components.

## Key Activities/Issues

- ❒ PIFSC supports a large multiyear cooperative agreement with the University of Hawaii at Manoa, the Joint Institute for Marine and Atmospheric Research. The current agreement was scheduled to expire in June 2009. Accordingly, the Center devoted considerable effort to assessing progress and spending plans in anticipation of a close-out. However, the agreement has been extended to September 2011. A new cooperative agreement will be established in the coming year.
- ❒ PIFSC continues to deal with the problems of maintaining aging facilities and providing adequate work space to accommodate a growing staff.
- ❒ Forecasting a significant increase in the Center's budget and associated growth in acquisitions and grants, the Office of Administration created a new acquisitions and grants group and a new supervisory position to lead the group. The group is well positioned to meet the Center's expanded requirements.
- ❒ Preparations continue for the movement of staff and equipment to the NOAA Pacific Regional Center's warehouse science support facility (Building 130), scheduled for early 2011.

### *Center's Small-boat Program Vital to Research in Nearshore Habitats*

The Pacific Islands Fisheries Science Center relies primarily on large NOAA ships, like the *Oscar Elton Sette*, for open ocean studies, monk seal research in the remote Northwestern Hawaiian Islands, and coral reef research across the Pacific Islands Region. But recently expanded research on marine mammals, bottomfish, and other marine life in nearshore habitats, particularly short-range studies in the main Hawaiian Islands, has created a greater need for smaller, more agile vessels capable of working in coastal waters. Accordingly, the Center has recently instituted a program to manage use of small research vessels. The Center maintains several vessels in the 15-25 ft range and charters larger craft as needed.

Small-boat operations are overseen by Chad Yoshinaga in the Center's Administrative Services group. Chad developed comprehensive guidelines for small vessel deployment, safety, and reporting. He ensures that small-boat users are capable boat handlers and are fully trained in NOAA and PIFSC small-boat policies and safety practices. All small boats used, including chartered vessels, must meet strict NOAA requirements for safety. Chief scientists in charge of extended small-boat field operations are governed by Center-approved Mission Plans and must submit Mission Reports upon completion of their cruise. Chad created a Web page on the Center's Intranet to post small-boat guidelines, Mission Plans, and Mission Reports. He conducts regular trainings for Center staff likely to be engaged in small-boat operations.

The data collected from the small-boat platforms are essential for the analysis and assessment of insular marine ecosystems and habitats. During 2009, small boats were deployed in the main Hawaiian Islands to survey cetaceans, study monk seals, map the seabed, and observe bottomfish. Several small boats were used to assess marine debris and coral reef damage in the wake of a major tsunami that struck American Samoa in September 2009.

# Information Technology Services

The Information Technology Services (ITS) group provides broad technical services in support of the Center's needs in communications, computing, data management, and more. It is organized into two support groups—the System Administrators and the Systems Design Team. The System Administrators are responsible for maintaining, monitoring, and upgrading computer hardware, software, networking, communications, and related infrastructure and ensuring Center compliance with growing IT security requirements. The System Design Team is responsible for the design, development, and maintenance of databases and related software applications to support the Center's scientific and administrative programs.

## System Administrators

During 2009, System Administrators maintained and enhanced IT infrastructure for Center staff in the face of significant logistical challenges, including the continuing dispersal of scientists to work centers away from the Dole Street facility. Expansion of staff at the Kapiolani Boulevard work site required augmented networking capability and other onsite IT support there. Upgrading of office trailers for Coral Reef Ecosystem Division staff at the Kewalo Research Facility required installation of IT systems in the new trailers and connections into the PIFSC network. Likewise, the growth of staff at Dole Street required installation of power and network connectivity for a new office trailer. Finally, System Administrators provided significant support to Center staff in software installation and maintenance, including regular rollouts of mandatory security patches. Several accomplishments of System Administrators in 2009 are noteworthy:

- Upgraded connectivity between PIFSC work sites. Procurement and installation of an EIPDS circuit allows offices to communicate with each other at 10 mb per second.
- Implemented LANDesk software package that allows software security patches to be pushed to users' computer systems and enables remote administration of those systems.
- Enabled the connection of Macintosh computers into our network and expanded support for Macintosh computing across the Center.

## Systems Design Team

The ITS Systems Design Team helps Center scientists, data managers and administrators complete their missions by designing and building cost-effective, time-saving information management solutions. It provides database design and management expertise and develops and maintains databases and related applications. While the team's primary responsibility is with PIFSC, it also provides critical data systems support to the NOAA Fisheries Pacific Islands Regional Office and participates actively in cross-regional partnerships including the NOAA Fisheries' Enterprise Data Management program and the national Fisheries Information System.

In 2009, the Systems Design Team worked on several key projects to improve scientific and administrative information systems at the Center. Among notable accomplishments were the following:

- Designed, developed and implemented a Web application and database to help manage the Center's accountable property.
- Designed, developed and implemented Phase I of the Hawaiian Archipelago Bottomfish Sampling database, including data tables, data views and history tables. Users were trained in database design principles, Web-based data entry and data retrieval using Data Trawler.
- Worked with staff of the Protected Species Division to revise the Turtle Data Processing System. Completion is scheduled for late 2010.
- Consulted with data managers in the Protected Species Division on a plan for Phase I of the revised monk seal database.
- Made significant enhancements to Web applications for the Center's personnel system and budget system. Security measures were increased in the Oracle databases.
- Made enhancements to Data Trawler, an application enabling online access of PIFSC staff to Oracle databases for research and monitoring.
- Developed, tested, deployed, and supported a Web application enabling noncommercial bottomfish fishers in Hawaii to report their catches online.
- Worked with other NOAA Fisheries staff to publish official application guidelines and data requirements for vendors seeking to develop electronic versions of the Hawaii longline fishery logbook.
- Continued to provide support for the Longline Observer Data System used by PIRO to monitor the Hawaii longline fishery.
- Continued projects to modernize the Hawaii Longline Logbook Data System and integrate multiple fisheries-dependent data sources. Developed integrated data products derived from U.S. longline logbook statistics and landings records to support mandatory reporting of U.S. fishery statistics to regional fishery management organizations.
- Continued to develop and support the InPort Metadata Catalog, the software tool now being used by NOAA Fisheries to inventory and document the agency's data holdings. InPort currently contains more than 4000 information assets cataloged by 10 NOAA Fisheries components and partner organizations.

*Laptop computers for traveling staff are regularly screened to ensure the security of the Center's networks and information assets.*

# Scientific Information Services

The Scientific Information Services (SIS) group provides comprehensive support to the Pacific Islands Fisheries Science Center in the management and dissemination of scientific information collected, acquired or produced by Center programs. SIS handles many kinds of information, including fisheries data, scientific publications, educational materials, graphics, and library resources, and also manages the Center's Web presence.

SIS data services staff carefully screen and validate catch reports provided to NOAA Fisheries by commercial fishing vessel captains and enter the information into electronic databases. Data collected by the Center's fisheries research programs are also captured and archived. SIS strives to provide full access to the data for statistical analyses, stock assessment studies, and fishery reports while meeting legal requirements to protect the confidentiality of commercial fishing enterprises. SIS information specialists provide customized data queries and similar data services to PIFSC researchers and clients outside the Center. In 2009, SIS made significant progress in its PIFSC Metadata Project to compile, organize, and publish information describing all data holdings of the Center, including data reported to NOAA Fisheries by fishers and data collected by PIFSC research programs. SIS staff worked with metadata managers in other Center programs to meet an agency-wide milestone for registration of key metadata. SIS staff also compiled and reviewed information on current PIFSC practices for data backup and archival and launched a project to develop a comprehensive set of Center-wide guidelines, best practices and protocols to ensure the integrity and security of our data assets; that project will be completed in 2010.

SIS publications staff carefully manage the editing, review, and approval of journal manuscripts, technical reports, conference presentation abstracts, Web site articles, and other documents prepared by Center researchers to ensure material disseminated by the Center or submitted for publication externally meets NOAA information quality standards. The same service is provided for operating plans and cruise reports documenting PIFSC research expeditions on the NOAA Ships *Oscar Elton Sette* and *Hi'ialakai* and chartered commercial research vessels. In 2009, cruise document management was expanded to cover the growing number of research projects carried out from small boats. Finally, the publications group also designs, edits and publishes the Center's Annual Report. SIS maintains a comprehensive registry of metadata on PIFSC scientific documents.

SIS helps Center staff at all work sites with graphical design and layout, photography, digital image processing, and other graphics needs. In 2009, SIS continued to meet needs of Center scientists for posters, banners, leaflets and other materials for presentation at conferences. Our SIS graphics specialist also assisted partner agencies and provided key support for NOAA outreach events and public educational activities.

The SIS roster includes the PIFSC Librarian, who manages a NOAA science reference library at the Dole Street facility for use by Center staff and the public. The library has extensive up-to-date collections of scientific journals and technical books on fisheries science, oceanography, marine ecology, conservation biology, and other subjects with an emphasis on Pacific Island insular and oceanic ecosystems. Many journals are available in electronic format and Center library services are extended to scientists in satellite facilities through e-mail and the Internet. In 2009, the PIFSC Librarian continued to expand the Center's digital reference collections of older research material, scanning Special Scientific Reports, produced by the Honolulu Laboratory during 1949–1982, into PDF format. She expanded the library's comprehensive Oracle database of PIFSC document metadata, enabling ready public access to the Center's publications via the PIFSC Web site.

SIS is responsible for developing and maintaining the PIFSC Web site. The PIFSC webmaster disseminates the Center's scientific reports, public data products, news about current research activities and other information over the Internet. Web content is produced by subject matter experts in the Center's research divisions. In 2009, we continued to improve our Web presence and prepared for the 2010 transition to a new NOAA Fisheries design and website structure. We continued to provide updates on Center research through the online PIFSC Quarterly Research Bulletin.

SIS also manages the PIFSC Intranet under the leadership of the Librarian, providing Center staff with comprehensive information about administrative support resources; policies and procedures; reports of current Center research activities; NOAA Fisheries news; announcements of upcoming meetings, seminars, and other events; current cruise schedules; and more. In 2009, priority was given to regular updating of Intranet contents, including in-house administrative procedures, policy directives, cruise documents, and announcements of Center events and new staff publications. New sections were added enabling ready access to mission plans and reports for small-boat operations and NEPA documents that assess environmental impacts of the Center's research projects.

As a diverse information support group, SIS aims to ensure that marine resource managers, research colleagues, and the public have ready and timely access to important data products and the research findings of Center scientists. SIS has established several milestones for completion in 2010:

- ❒ Update Scientific Information Services contents on the PIFSC Intranet
- ❒ Redesign the PIFSC Web site in accordance with new NOAA Fisheries guidelines
- ❒ Chair a PIFSC Working Group to draft a policy and develop best practices for data archival and security
- ❒ Create online catalogs of metadata for PIFSC scientific data holdings

*Above: University of Hawaii students work part-time to help the Center with timely processing of commercial fisheries catch data. Facing page: The NOAA Pacific Regional Center, to be constructed on Ford Island in Pearl Harbor, is scheduled for completion in late 2013 (architect's rendering).*

# Coral Reef Ecosystem Division

In support of NOAA's Coral Reef Conservation Program (CRCP), the Coral Reef Ecosystem Division (CRED) conducts research to support management and conservation of coral reef ecosystems in the U.S.-affiliated Pacific Islands. CRED maintains a comprehensive, integrated observing system involving long-term ecological monitoring surveys, oceanographic surveys, and benthic habitat mapping. CRED leads the Pacific Reef Assessment and Monitoring Program (RAMP) with collaboration by federal, state, and territorial agencies, nongovernmental organizations, and academic partners. RAMP involves biennial surveys of coral reefs throughout the main Hawaiian Islands (MHI), Northwestern Hawaiian Islands (NWHI), territories of Guam and American Samoa, Commonwealth of the Northern Mariana Islands (CNMI), and Pacific Remote Island Areas (PRIA). Standardized methods are used enabling comparative analyses of spatial patterns and temporal variability of coral reef ecosystems at more than 50 islands and atolls. Survey sites represent diverse gradients of biogeography, environmental conditions, and human activity leading to improved understanding of the complex processes influencing the health of coral reef ecosystems. RAMP surveys provide the basis for comprehensive Integrated Ecosystem Assessments (IEAs) for each region that will support improved coral reef ecosystem management and mitigation of adverse impacts from climate change, fishing, pollution, and other stressors.

Facing page: *Pink anemone fish (Amphiprion perideraion), and the magnificent sea anemone (Heteractis magnifica).*

The CRED is organized into 5 programs:

- *The Oceanography and Water-quality Program* monitors key oceanographic processes, environmental parameters, and water-quality conditions using (1) in situ observations collected from ships and small boats, sea-surface and subsurface moored instrument arrays, and satellite-tracked drifter buoys; (2) data from satellite-borne remote sensors; and (3) oceanographic models. The program also develops tools and instruments to improve IEAs, including ecological acoustic recorders (EARS) that monitor activities of marine biota and vessels through the sounds they produce and bottom camera (BotCam) bait stations that help assess relative abundance and composition of bottomfish stocks.
- *The Ecosystem Monitoring and Analysis Research Program* uses complementary and overlapping methods to quantitatively and qualitatively document the spatial distribution, density, species composition, size structure, and condition of corals, other invertebrates, fish, and algae during biennial Pacific RAMP surveys. Site-specific Rapid Ecological Assessments involve stationary-point counts, roving diver surveys, belt transects, photoquadrats, video transects, and specimen collections to assess detailed information about individual species. Towed-diver surveys, involving diver observations and the use of digital video and still cameras, provide broad spatial coverage and information on benthic composition and the abundance and distribution of ecologically important fish and macroinvertebrate taxa. EARs are used to document biological changes over time scales shorter than those studied during biennial Pacific RAMP cruises. Autonomous reef monitoring structures (ARMS) are used to systematically assess spatial patterns and temporal trends in indices of cryptic invertebrate biodiversity and to contribute to the international Census of Marine Life's Census of Coral Reef Ecosystems project.
- *The Benthic Habitat Mapping Program* uses multibeam echo sounders, towed cameras, Autonomous Underwater Vehicles (AUVs), and other tools to create benthic habitat maps that describe the depth, character, and composition of the seafloor and associated biota in and around coral reefs.
- *The Marine Debris Program*, with support from NOAA's Marine Debris Program, the CRCP, and the Papahānaumokuākea Marine National Monument uses towed-diver, swim, and aerial surveys to assess the type, density and distribution of derelict fishing gear and other marine debris in the MHI and NWHI. CRED divers manually remove marine debris from reefs and shorelines. The program also conducts research to better understand the impacts of marine debris on marine ecosystems and develop cost-effective means to locate and remove marine debris at sea.
- *The Data Management and Integration Program* formats, documents, synthesizes, integrates, distributes, and archives data collected by CRED staff and partner scientists. The program applies quality controls to the data, enters them into an Oracle database or ArcSDE geodatabase, and produces metadata compliant with NOAA's Coral Reef Information System and the PIFSC Metadata Project. The databases facilitate access to data and enable spatial and temporal analyses and integration of CRED's multidisciplinary ecosystem observations.

The CRED has 70 staff members, including 8 federal employees, 61 employees of JIMAR, and students; 8 of the JIMAR employees are graduate students pursuing doctoral or master's degrees. Grants—primarily to JIMAR—accounted for the largest CRED expenditures in FY 2009.

## Key 2009 Accomplishments

- Established scientific liaisons to improve communications with partners in American Samoa, Guam, the CNMI, the PRIA, the NWHI, the MHI, and the Western Pacific Regional Fishery Management Council (WPFMC).

| CRED Personnel | |
|---|---|
| Federal | 8 |
| JIMAR | 61 |
| Other | 1 |
| *Total* | 70 |

| Coral Reef Ecosystem Division—FY 2009 | | |
|---|---|---|
| | $ | % |
| Salaries and benefits | 768,257 | 17.8 |
| Grants | 2,038,324 | 47.3 |
| Contracts | 667,494 | 15.5 |
| Travel, transportation, charters, printing, supplies, equipment | 834,419 | 19.4 |
| *Total* | $4,308,494 | |

- Drafted the Coral Reef Ecosystem Monitoring Report for Mariana Archipelago: 2003–2007 and solicited reviews by partners. The report describes reef surveys during Mariana Archipelago RAMP cruises conducted in 2003, 2005, and 2007 and assessments of coral reef ecosystems in this region.
- Removed 36.3 metric tons of derelict fishing gear from the NWHI. The Marine Debris Program and partners have removed nearly 701.8 tons of marine debris from the NWHI since 1996.
- Created integrated, shallow (0–400 m) bathymetric maps using multibeam, LIDAR, and IKONOS imagery for 12 islands and atolls.
- Conducted multibeam mapping of Honolulu Harbor and offshore benthic habitats in the main Hawaiian Islands to support needs of NOAA and local partners.
- Continued collaborative mapping and interpretation of mesophotic coral ecosystems in the Au`au Channel and around Kaua`i using a towed camera.
- Posted more than 75 new benthic habitat mapping products for the Hawaiian Archipelago, Mariana Archipelago, American Samoa, and Pacific Remote Island Areas online at http://www.soest.hawaii.edu/pibhmc.
- Led Pacific RAMP cruises on the NOAA Ship *Hi`ialakai* to Guam, the CNMI, and Wake Atoll and participated in an annual NWHI RAMP cruise to continue long-term integrated ecosystem monitoring. Partners included the University of Guam, Guam Coastal Management Program, San Diego State University, University of Hawai`i, and Papahānaumokuākea Marine National Monument.
- Monitored oceanographic conditions and water quality at 54 islands, atolls, and banks in the U.S.-affiliated Pacific Islands with 23 moored and telemetered surface buoys and 285 subsurface oceanographic moorings. Expanded monitoring to include the Kimbe Bay Marine Protected Area as part of the Coral Triangle Initiative.
- Collected baseline carbonate chemistry data in the Mariana Archipelago and NWHI to support studies of climate change-induced ocean acidification and its impacts on coral reef ecosystems. Partners included the NOAA Pacific Marine Environmental Laboratory and NOAA's Coral Reef Watch program.
- Completed 4 missions using the SeaBED AUV to develop protocols for characterizing benthic habitats and communities and surveying groundfish; the studies were a collaboration with the Northwest Fisheries Science Center.
- Deployed 30 ARMS in the CNMI, 12 at Wake Atoll and Guam, and 33 in the main Hawaiian Islands.

## Challenges, Problems, and Limitations

The primary challenge for CRED is to provide timely, unbiased scientific information on the condition of coral reef ecosystems in the U.S.-affiliated Pacific Islands and processes affecting them. The information must be easily interpreted and presented in a manner useful to resource managers, policymakers, and other key stakeholders at local, regional, national, and international levels. To meet these challenges, CRED needs to continue long-term monitoring of reefs, integration of ecosystem observations, and studies of reef communities and processes across the Pacific Islands Region. CRED also needs to improve methods used to identify and understand complex spatial and temporal patterns and relationships in biological and environmental data. These challenges will require a sustained commitment of funding and extensive access to NOAA research vessels.

## Future Focus and Direction

In support of the NOAA Coral Reef Conservation Program, CRED will continue to focus on improving responsiveness to local management needs for scientific information to address impacts of climate change, fishing, land-based pollution, and other stressors. Scientific liaisons will work closely with resource managers to improve the relevance and usefulness of CRED products. CRED will continue to improve the format and content of its coral reef ecosystem monitoring reports to better meet management needs; organize Pacific-wide, integrated ecosystem observations into relational geospatial databases; and make the data publicly available. Efforts are underway to incorporate CRED's suite of integrated biological, oceanographic, and habitat observations into NOAA's Integrated Ocean Observing System and the Global Ocean Observing System frameworks as a model for ecological observing systems.

CRED is extending the suite of ecosystem observations to more effectively assess, monitor, and understand the ecological impacts of climate-change driven ocean acidification, including establishing baseline observations of carbonate chemistry, calcification rates, and cryptic invertebrate biodiversity.

CRED is augmenting Pacific RAMP visual surveys and benthic habitat mapping to support the development of annual catch limits (ACLs) for coral reef fish species in the Pacific Islands Region, as mandated by the Magnuson-Stevens Reauthorization Act of 2006. Expanded research to support reef fish population assessments will involve life-history studies, increased replication of surveys around populated islands, and efforts to improve understanding of reef fish distributions in habitats and depth ranges not currently surveyed as part of the Pacific RAMP.

Specifically, in 2010 the CRED will accomplish the following objectives:

- Lead Pacific RAMP cruises to American Samoa, the PRIA, the NWHI, and the MHI

- ❒ Lead an exploratory fish population assessment cruise to the Mariana Archipelago using multibeam bathymetry, bottomfish BotCam and baited remote underwater video stations (BRUVS), active acoustics, and a SeaBED AUV to characterize deepwater benthic habitats and develop robust fishery-independent methods to assess bottomfish resources
- ❒ Complete the Coral Reef Ecosystem Monitoring Report for the Mariana Archipelago: 2003–2007
- ❒ Continue to establish a global baseline of cryptic coral reef biodiversity using ARMS
- ❒ Provide population estimates and fishery impact assessments for coral reef fishes in the U.S.-affiliated Pacific Islands based on visual survey and habitat mapping data as part of collaborative work to develop annual catch ACLs for coral reef fishes
- ❒ Explore use of remote sampling methods to increase understanding of fish distributions in depths below visual survey range
- ❒ Continue to establish a baseline understanding of carbonate chemistry processes in Pacific island reef habitats
- ❒ Begin to assess the ecological impacts of ocean acidification on reef ecosystems by monitoring calcification rates of corals and crustose coralline algae using coral cores and calcification plates
- ❒ Continue development of tools to measure larval transport and recruitment in American Samoa, the Mariana Archipelago, and the Hawaiian Archipelago

*The humphead parrotfish (left) and the humphead wrasse are valuable members of coral reef ecosystems in the Pacific Islands Region.*

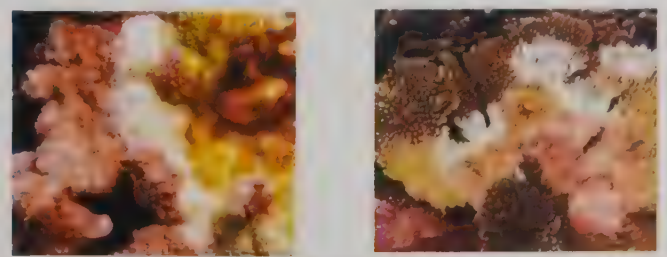
## *Assessment of Coral Health and Disease Part of Foundation for Monitoring Impacts of Climate Change*

As NOAA faces the challenge of monitoring impacts of climate change on marine ecosystems, the importance of establishing reliable baseline information about current ecosystem status is paramount. Recent surveys by PIFSC have enabled impact assessments for coral reefs of the Pacific Islands Region by documenting the current status of corals, other invertebrates, algae, fish and other ecosystem components.

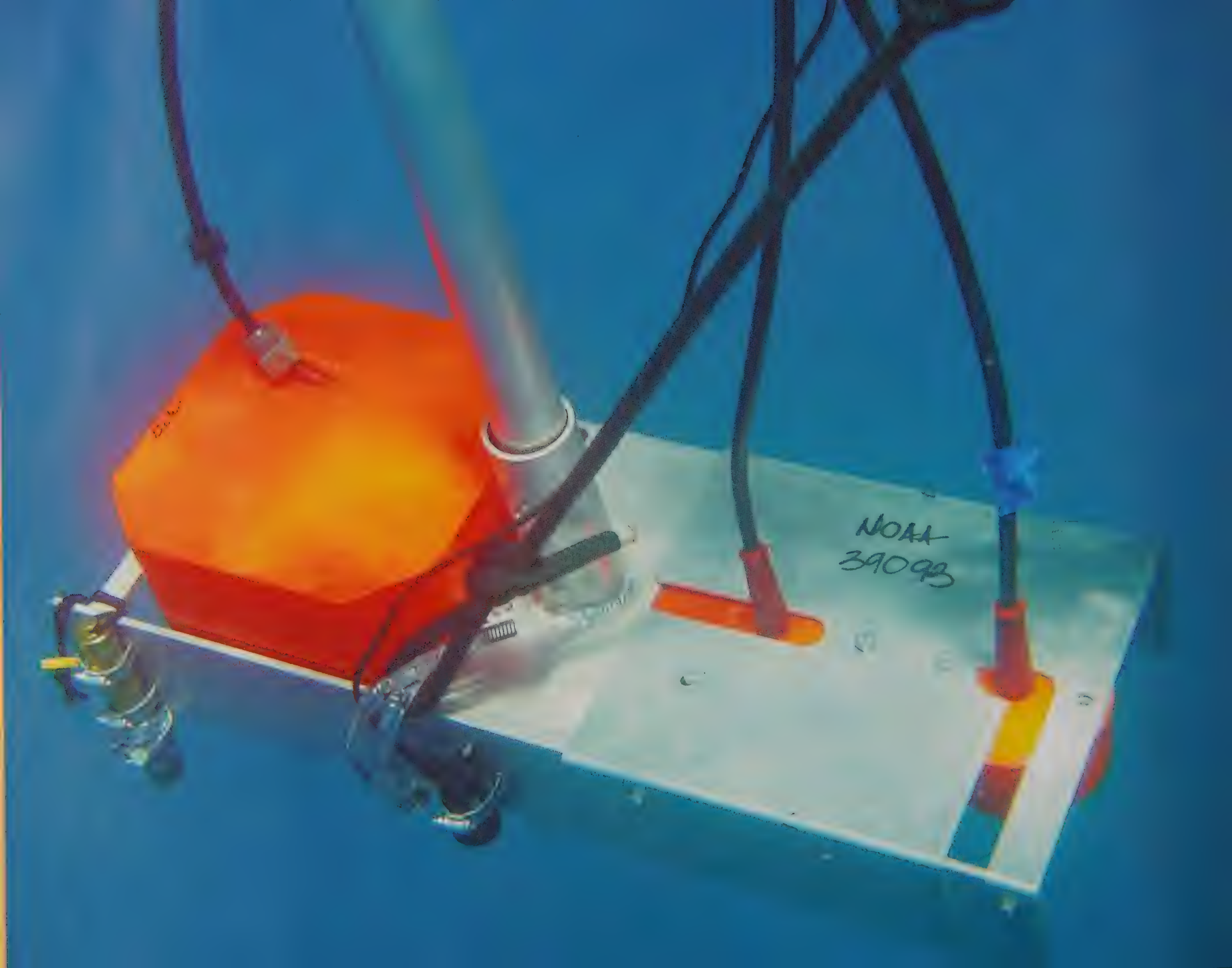
An important aspect of the coral surveys is the assessment of coral disease and health across the spectrum of reef habitats in the Region, from those near human population centers to others at remote, unoccupied atolls. During 2006 and 2007, the Coral Reef Ecosystem Division conducted a comprehensive, quantitative coral disease assessment at seven largely unpopulated U.S. coral atolls and islands in the central Pacific collectively known as the Pacific Remote Island Areas (PRIA): Johnston, Palmyra, Kingman, and Wake Atolls, and Howland, Baker, and Jarvis Islands. Data from 80 survey sites revealed 6 broad categories of coral disease affecting 12 different genera of stony corals. The most geographically and taxonomically widespread disease was skeletal growth anomalies, detected at nearly 40% of survey sites and on six different anthozoan genera. White syndrome, or acute tissue loss, was the most prevalent disease found and afflicted several genera of stony corals, including Acropora, Montipora, Goniastrea, and Platygyra. Pigmentation response and other sublethal lesions, such as algal and cyanophyte infections, and tube-worm infestations, were seen infrequently. In general, the prevalence of coral diseases in the PRIA was low and variable across genera.

Coral disease affects the structure and dynamics of individual species and the coral community. It kills individual coral organisms or reduces their growth and fecundity. Pathogens may impede the ability of corals to compete for space and other critical resources. The susceptibility of corals to disease is influenced by temperature, acidity, and other abiotic properties of the ocean environment and is, therefore, affected by climate change. The PRIA coral disease survey data are a valuable baseline for monitoring such effects in the coming decades.

The coral disease research was directed by Bernardo Vargas-Angel, a CRED scientist with the Joint Institute for Marine and Atmospheric Research, and recently published in the peer-reviewed journal *Bulletin of Marine Science*.



*In white syndrome, tissue is lost to the skeleton, leaving a bright white surface of coral exposed. Acute tissue loss is often measurable in days and can [illegible]*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# Ecosystems and Oceanography Division

The Ecosystems and Oceanography Division (EOD) conducts research to advance our understanding of the structure and dynamics of Pacific basin marine ecosystems. In particular, EOD seeks to understand how marine populations change directly in response to changes in their predators and prey and indirectly as a result of broader habitat-based changes in the ocean climate, including El Niño, La Niña, and other interannual or decadal events.

EOD research covers topics on various spatial scales ranging from fine-scale habitat characterization to basin-scale oceanography, and diverse temporal scales ranging from short-term individual foraging behavior to long-term ecosystem changes and population trends. Accordingly, a variety of approaches are necessary, including collaborations with scientists in other PIFSC divisions, other government agencies, academic departments, industry, nongovernmental organizations, and foreign institutions.

EOD research is organized into three major themes:

- Insular Habitat and Ecology research focuses on understanding the dynamics of island-associated species and processes.
- Pelagic Habitat and Ecology research considers the ocean from the perspective of large pelagic animals.
- Ecosystem Oceanography research identifies changes in the ocean that may affect the marine ecosystem.

EOD provides scientific advice to support improved stock assessment and fisheries management, develops indicators of ecosystem changes, and publishes scientific findings related to effects of habitat and environment on individuals, populations, ecosystems, and fisheries. To accomplish these goals, EOD conducts research at sea using a variety of platforms including deep diving submersibles, remotely operated vehicles, and SCUBA, and operates from both small and large research vessels and commercial vessels. EOD employs a broad spectrum of advanced technologies and tools, including pop-up satellite archival tags, animal-borne instruments such as CRITTERCAM, shipboard and moored echo sounders, satellite remotely sensed oceanographic and atmospheric data products, ocean circulation models, and ecosystem models.

EOD has 11 staff, including 6 federal employees and 4 JIMAR employees. Salaries and benefits made up the largest share of expenditures in the EOD budget.

The EOD Chief also serves as Principal Investigator for the NESDIS-funded Central Pacific OceanWatch Node (http://oceanwatch.pifsc.noaa.gov/) managed by a JIMAR oceanographer. This program acquires, processes, and archives a suite of satellite remotely sensed oceanographic data and data products and distributes them via the OceanWatch Live Access Server to a diverse group of users in government agencies and the private sector. OceanWatch also actively engages in science outreach activities and educational events.

## Key 2009 Accomplishments

- Completed a paper describing changes at the top of the central North Pacific pelagic ecosystem
- Completed a paper applying an ECOPATH ecosystem model to estimate the carrying capacity of French Frigate Shoals for the endangered Hawaiian monk seal
- Completed a paper on the growth of the deepwater coral *Gerardia* sp.
- Coauthored a paper on reducing seabird bycatch in the Hawaii longline fishery
- Coauthored two papers on aspects of climate and marine ecosystems
- Conducted a research cruise to explore deepwater coral habitats in the main Hawaiian Islands
- Conducted an oceanographic research cruise to study the Transition Zone Chlorophyll Front
- Conducted collaborative research with Hawaii longline fishers to measure the depth and temperature of waters fished by commercial longline gear using temperature and depth data recorders attached to the gear.

**EOD Personnel**

| | |
|---|---|
| Federal | 6 |
| JIMAR | 4 |
| Other | 1 |
| *Total* | 11 |

**Ecosystems and Oceanography Division—FY 2009**

| | $ | % |
|---|---|---|
| Salaries and benefits | $848,459 | 76.8 |
| Grants | 96,098 | 8.7 |
| Contracts | 2,650 | 0.2 |
| Travel, transportation, charters, printing, supplies, equipment | 157,610 | 14.3 |
| *Total* | $1,104,797 | |

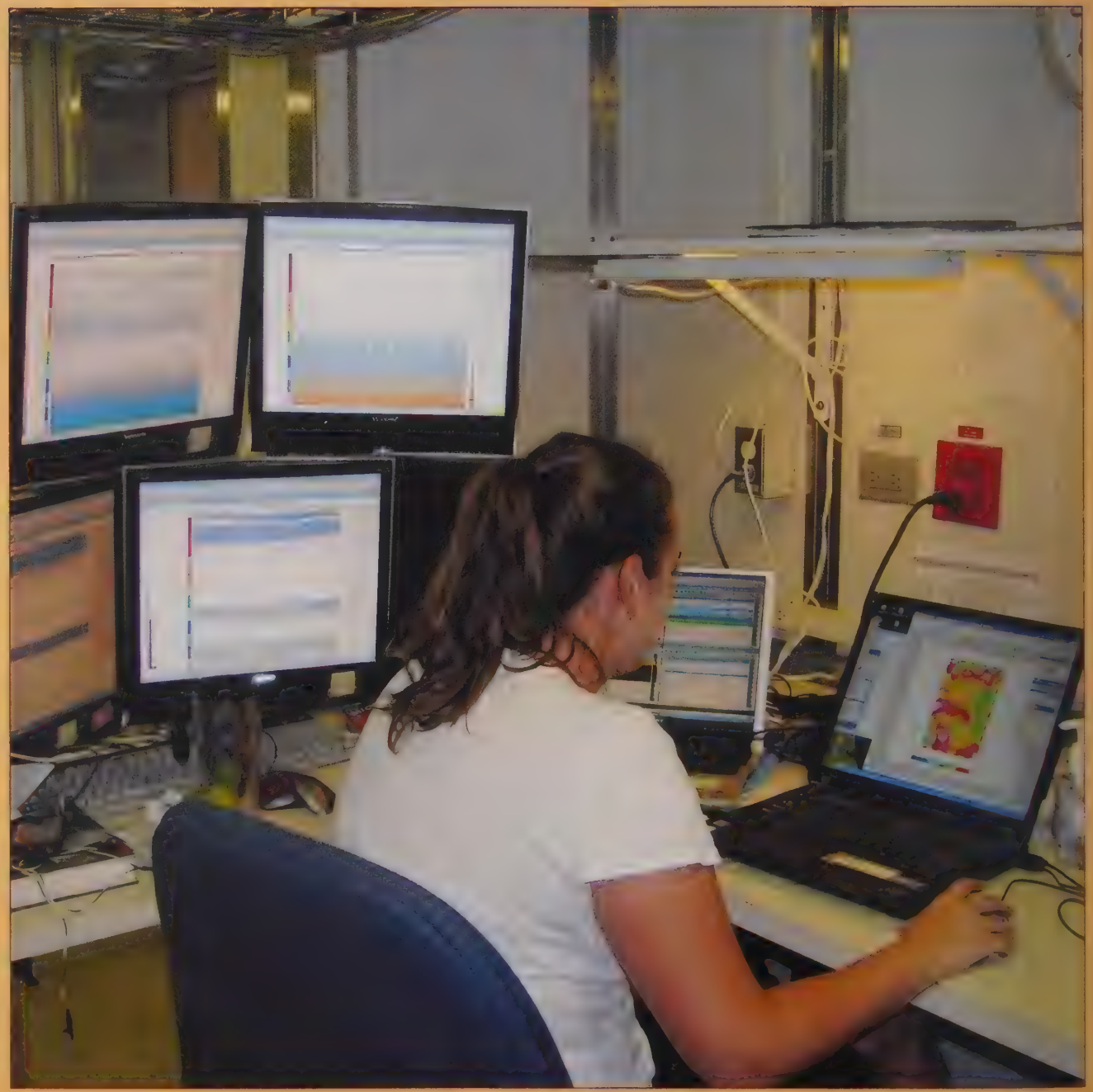
*Facing page: Sonar instruments pole-mounted on small boats are used to study the life history of opakapaka, a primary target of the Hawaii bottomfish fishery.*

## Challenges, Problems, and Limitations

Noise contamination in the acoustic data collected by the NOAA Ship *Oscar Elton Sette* continues to be a problem for research surveys of tunas and their forage. Due to funding limitations at the Pacific Marine Center (NOAA), the problem has yet to be resolved.

## Future Focus and Direction

Through collaboration with the Protected Species Division, EOD is continuing to collect information on the occurrence of cetaceans at various locations in the central North Pacific using passive acoustic recorders deployed on the seafloor and attached to sea gliders. The Division also continues to study changes in the subtropical gyre marine ecosystem caused by fishing and climate processes using remotely sensed oceanographic data, commercial fishery statistics, NOAA Fisheries observer data, and models of climate and ecosystem dynamics.



*Right: Studies of the pelagic ecosystem include acoustic surveys to measure the density and composition of fishes, key forage species and other organisms in the water column. Scientists on the NOAA Ship Oscar Elton Sette monitor hydroacoustics data collected by the ship's sonars, operating at various frequencies (computer monitors, left). At the same time, they view concurrent information on sea level height (right monitor), derived from sensors on a satellite, to map mesoscale eddies in the survey area. Eddies influence the distribution and biomass of organisms in the water column.*

## *Direct Measurements Show Hawaiian Gold Coral Grows Much Slower Than Previously Estimated*

Precious corals like the gold coral, *Gerardia* sp., are a valuable component of benthic ecosystems on the deep sea slopes and seamounts of the Pacific Islands Region. Formulating measures to conserve these resources requires knowledge of coral biology and population dynamics. Particularly important is an understanding of growth rate and longevity. Research published in 2002 by a University of Hawaii scientist indicated that gold coral in Hawaii grow at 1 mm per year radially (across the coral stem), consistent with a maximum life span of about 70 years. The estimate was based on counts of growth rings visible in cross sections of the coral's basal stem and assumed that each ring represented one year of growth. In 2006, other scientists published alternative estimates of radial growth for Hawaiian gold coral based on radiocarbon dating; the radiocarbon ($^{14}C$) analysis indicated much slower growth, 0.015–0.045 mm per year, and a maximum life span in the range of 450–2740 years for the specimens studied. Such a discrepancy in growth rate estimates has a big impact on management strategy. Given evidence of such slow growth and extreme longevity, the Western Pacific Regional Fishery Management Council placed a 5-year moratorium on harvest of gold coral in U.S. waters of the western Pacific, extending through June 2013.

To resolve the uncertainty about growth, PIFSC scientist Frank Parrish teamed with coral specialist Brendan Roark of Texas A & M University to measure growth directly for a selected sample of gold coral colonies in the Hawaiian Archipelago. In 2007, they used Hawaii Undersea Research Laboratory submersibles to locate 48 gold coral specimens that had been measured and marked during surveys 1-9 years earlier. Located across a broad area of the archipelago spanning 5 degrees of latitude, some of the corals grew on summits of seamounts and others on slopes of islands or shallow banks. During the return visit by the submersible, observers measured the height of each marked colony and repeated the measurements from different view angles to assess measurement error. Given the magnitude of measurement variability, the mean colony height growth rate of 0.23 cm per year was not statistically different from zero, but strikingly different from the corresponding estimate of 6.6 cm per year growth in colony height based on the ring count data. Radiocarbon analysis of a live gold coral specimen collected by a submersible from Cross Seamount revealed a growth rate almost identical to the rate estimated from direct measurements of the marked colonies. Given such extremely slow growth, decades would be required before growth of the marked colonies could be measured directly with enough precision to validate the radiocarbon analysis. Nevertheless, the preponderance of evidence indicates that extreme caution in managing the harvest of gold coral is warranted.

The work of Parrish and Roark was published in the *Marine Ecology Progress Series*.

*Gold coral colonies were measured from a submersible, then remeasured 1–9 years later to estimate their growth rate. Numbered concrete flower pots were used to mark the location of each colony.*

Reference: Parrish, F. A., and E. B. Roark (2009). Growth validation of gold coral *Gerardia* sp. in the Hawaiian Archipelago. Mar. Ecol. Prog. Ser., 397: 163-172. http:/ dx.d

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# Fisheries Monitoring and Socioeconomics Division

The Fisheries Monitoring and Socioeconomics Division (FMSD) specializes in collecting, processing, and analyzing data from U.S. fisheries in the Pacific Islands Region. The FMSD monitors U.S. fisheries and issues reports of fisheries statistics; provides official fisheries statistics to fulfill U.S. obligations for data exchange and reporting under several international agreements; provides technical support to help PIFSC partner agencies in American Samoa, Commonwealth of the Northern Mariana Islands (CNMI), Guam, and Hawaii develop and administer local commercial fisheries monitoring programs; coordinates programs to collect recreational fisheries data and establish biological sampling of fisheries in the Region; and conducts social and economic research on marine resource use. In addition to regular fishery reports, FMSD develops custom data products to satisfy information requests from fisheries scientists and managers.

The FMSD is organized into four programs:

- *The Western Pacific Fisheries Information Network* (WPacFIN) is a cooperative program involving a central office at PIFSC and collaborating local fisheries agencies in American Samoa, CNMI, Guam, and Hawaii. The WPacFIN central office compiles fisheries information collected by these agencies and provides technical expertise and software tools to help them collect fishery-dependent data to meet the needs of local, federal, and international fisheries management organizations.
- *The Fisheries Monitoring and Analysis Program* (FMAP) collects, processes, and reports federally mandated longline logbook data. FMAP also provides information on federally regulated fisheries to fishers and industry constituents and makes nonconfidential data available to fishers and other clients. FMAP conducts outreach to improve PIFSC communication with fishers. The program's Barbless Circle Hook Project fosters use of barbless hooks to reduce and mitigate interactions of recreational shoreline fishers with protected species such as sea turtles and monk seals.
- *The Economics Program* (EP) contributes to Pacific Islands Region fisheries management by assessing the economic health and capacity of fishing fleets, monitoring fleet and vessel costs and earnings, studying fish prices and markets, developing models to examine economic impacts of fisheries regulations, and evaluating direct-use and indirect-use values of living marine resources.
- *The Human Dimensions Research Program* (HDRP) studies the "people" side of fishing and other uses of marine ecosystems in the Pacific Islands Region. HDRP research complements biophysical and economic studies by exploring social and cultural benefits and values associated with marine resources and examining the role that institutions and traditional marine use practices can play in ensuring sustainable use and conservation in the current socioeconomic context.

*Facing page: Fresh ahi tuna caught by local fishing vessels are landed on the Honolulu waterfront and auctioned to restaurants, fish dealers and other buyers to satisfy consumers in Hawaii and the mainland United States.*

A small group of staff works directly under the Division Chief to provide core administrative and technical support to the primary FMSD programs.

FMSD has a staff of 31 including 13 federal employees, 17 JIMAR/contract employees, and a UH student assistant. Personnel and grants made up the largest proportion of expenditures in FY 2009.

## Key 2009 Accomplishments

FMSD provides many products and services on a recurrent basis, including quarterly and annual summaries of catch and effort data for longline fisheries in Hawaii and American Samoa, sections of annual reports for Fishery Management Plans, and annual inputs of fishery statistics to Fisheries of the United States. The Division's major accomplishments and new initiatives in 2009 included the following:

- Provided technical support to fishery offices in American Samoa, CNMI, Guam, and Hawaii to improve data collection and reporting.
- Conducted new fast-track quota monitoring systems for the Hawaii pelagic longline and deep slope bottomfish fisheries and provided in-season landings estimates used by the agency to regulate the fisheries.
- Provided support for U.S. fishery reports and data submittals to the Inter-American Tropical Tuna Commission, the Western and Central Pacific Fisheries Commission, and the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean.
- Compiled up-to-date statistics for U.S. fisheries of the Pacific Islands Region and made them publicly available on the WPacFIN Web site.
- Provided services to support management of the "Deep 7" bottomfish fishery in the main Hawaiian Islands by the Hawaii Division of Aquatic Resources, PIRO and the Western Pacific Regional Fishery Management Council (WPFMC).
- Expanded the outreach and education program for use of barbless circle hooks in Hawaii's shoreline recreational fishery.
- Began the digital scanning of logbook data for the Hawaii pelagic longline fishery, enabling efficient archival and searching of logbook records.

| FMSD Personnel | |
|---|---|
| Federal | 13 |
| JIMAR | 17 |
| Other | 1 |
| Total | 31 |

- Collaborated with the Information Technology Services group on Web-based reporting and electronic logbook solutions to make fishery reporting and monitoring faster, easier, and more accurate.
- Initiated long-term programs for biological sampling of fisheries throughout the Pacific Islands Region in cooperation with fisheries agencies in American Samoa, CNMI, and Guam.
- Chaired a session at a Fisheries Workshop in American Samoa to collect and evaluate information on historic fish catch and species composition, current fish catch rates and species abundance, and current management systems and challenges.
- Developed an economic demand model for Hawaii bottomfish to estimate the degree of market substitutability for various fish species at the wholesale market level and provide guidance for establishing and managing the total allowable catch (TAC) for main Hawaiian Islands Deep 7 bottomfish.
- Completed a manuscript on valuation of consumer choices in the spinner dolphin excursion industry and the implications for spinner dolphin conservation in Hawaii.
- Created the Fishing Ecosystem Analysis Tool, a new software application for spatially analyzing commercial fish catch data, linking them to socioeconomic conditions, and displaying the output in Google Earth and other formats.
- Established priorities for current and outyear funding of socioeconomics research, including development of new research programs and strengthening of core research capabilities.

## Challenges, Problems, and Limitations

The FMSD must meet increasing demand for improvements in fisheries data collection, management, and reporting. FMSD will continue to provide fishery statistics and scientific information to the WPFMC in support of Fishery Management Plans and Fishery Ecosystem Plans. New mandates for permitting, reporting, and management of total allowable catch under the Magnuson-Stevens Fishery Conservation and Management Act present a challenge in the Pacific islands, where regulations governing such management measures are generally absent. Other challenges are anticipated in fisheries data collection as the agency implements annual catch limits and other new mandates for catch monitoring in domestic and international arenas, including domestic recreational fisheries.

Marine resource managers seeking to implement catch shares, ecosystem-based approaches, or other new conservation measures need information about the effects of alternative management actions on different socioeconomic groups. Accordingly, the importance of economics and human dimensions research will continue to grow. The capacity to meet these research needs will be enhanced by stronger partnerships with other NOAA offices and other organizations.

## Future Focus and Direction

FMSD will need to maintain comprehensive metadata and documentation of data collections, procedures, and data products; collaborate effectively with partners; streamline and automate data collecting and processing; and improve delivery of products and services to constituents.

WPacFIN will work with partner offices to improve data collection programs in American Samoa, CNMI, Guam and Hawaii. WPacFIN will continue to develop databases and data processing applications, including

**Fisheries Monitoring and Socioeconomics Division—FY 2009**

| | $ | % |
|---|---|---|
| Salaries and benefits | 1,540,301 | 47.2 |
| Grants | 1,237,300 | 37.9 |
| Contracts | 127,536 | 3.9 |
| Travel, transportation, charters, printing, supplies, equipment | 357,456 | 11.0 |
| Total | $3,262,593 | |

*In Guam, when schools of atulai (bigeye scad) come close to shore, fishermen catch them with surrounding nets and share the harvest with family and friends.*

data integration tools. WPacFIN also will update contents of its Web site, service protocols for data requests, and documentation for data collection programs and database applications.

FMAP will help develop better ways for fishers to report catch and effort, including electronic logbooks and electronic transmission of catch reports. FMAP will improve fishery monitoring, make fishery data more accessible through the Center's Web site, and continue to promote the use of barbless circle hooks in shoreline fisheries.

EP will conduct a workshop on catch shares and a cost-earnings study of the main Hawaiian Islands bottomfish fishery. As funding permits, EP will broaden its research on the economics of coral reef resources, protected species, and ecotourism and conduct more economics research in American Samoa, Guam, and CNMI.

In 2010, HDRP will publish profiles of fishing communities in Hawaii and CNMI, complete a plan to monitor the human dimensions of coral reef ecosystems in the main Hawaiian Islands, and further develop its geographic information systems to support analysis of fishing impacts in the main Hawaiian Islands. HDRP will also continue to provide social science assistance and advice to partners in the Pacific and U.S. mainland.

In 2010, the socioeconomic programs (EP and HDRP) will operate in the Directors Office to enhance their scope across all five PIFSC research divisions.

## *Economic Analysis of Seafood Market Broadens Context for Management of Hawaii Bottomfish*

A recent study of the Hawaii seafood market has provided economic information to broaden the context for management of commercial bottomfish fishing in the main Hawaiian Islands. The multispecies fishery is regulated by limiting the annual MHI catch of 'Deep-7' bottomfish (a grouper and 6 species of deep-water snapper) to a Total Allowable Catch (TAC) level, determined from a biological assessment of the Hawaii bottomfish stock. There are concerns that recent changes to TAC management, coupled with increasing imports of fresh bottomfish from the South Pacific, may be distorting traditional demand and supply relationships in the Hawaii fishery. To address these topics, PIFSC economists estimated a generalized inverse demand model to examine market linkages and assess how prices may respond to a variety of potential TAC levels.

Using market data for 1996-2006, economists Justin Hospital and Minling Pan studied domestic catches and market prices of bottomfish and reef fish, along with data on competing imports of bottomfish from the South Pacific.

They found that Hawaii bottomfish prices are price elastic, which means that prices are not very responsive to changes in quantities of fish on the market. Import prices are even less responsive to changes in their own supply than are domestic bottomfish. All species in the demand system were found to be substitutes for each other in the marketplace, implying that MHI Deep-7 TAC decisions may have economic 'spillover' effects and suggesting that the mandated closure of the Northwestern Hawaiian Islands bottomfish fishery will likely increase local demand for bottomfish caught in the main Hawaiian Islands and imports from the South Pacific. Moreover, an increase in the overall supply of bottomfish and their substitutes would likely cause a decrease in prices for domestic bottomfish.

The findings of elastic prices and high levels of substitution make it difficult to balance conservation and economic considerations in the MHI bottomfish fishery. According to Hospital and Pan, if the MHI bottomfish TAC were temporarily reduced as a short-term conservation measure, consumers would likely suffer higher prices in the short term. And despite any price increases resulting from reduced catches, total revenues for the fishery may well decline. In the long term, though, as stock recovery enabled a higher TAC, consumers would likely enjoy lower bottomfish prices.

The economic information, published in a NOAA Technical Memorandum, enables fishery managers to examine trade-offs and frame more broadly based management policies that take into consideration not only biological, but also economic factors.

Reference: Hospital, J., and M. Pan. 2009. Demand for Hawaii bottomfish revisited: incorporating economics into total allowable catch management. U.S. Dept. Commer., NOAA Tech. Memo. NOAA-TM NMFS-PIFSC-20, 19 p. + Appendix [available at http://www.pifsc.noaa.gov/tech/NOAA_Tech_Memo_PIFSC_20.pdf].

# Fishery Biology and Stock Assessment Division

The Fishery Biology and Stock Assessment Division (FBSAD) conducts fundamental biological and ecological research on fish, sea turtles, and crustaceans caught in federally managed fisheries to enable improved understanding of the mechanisms that influence their distribution and abundance. Life history studies on age and growth, reproduction and fecundity, migration and movement, and mortality are conducted to provide estimates of vital rates for stock assessments and ecosystem-based management. Research is focused on tunas, billfishes, sea turtles, and other pelagic species; bottomfish; and, in the Northwestern Hawaiian Islands, lobster. Attention is also being directed toward coral reef and seamount species.

The research involves field surveys using a variety of sampling gears, laboratory studies of biological specimens, and analysis of data from experiments using conventional and electronic tags. Geochemical techniques are used to investigate trophic levels and population connectivity. New fishing technologies are developed, tested, and promoted internationally to reduce fisheries bycatch and effects of pelagic longline and other fisheries on populations of sea turtles, seabirds, sharks, and other species caught incidentally. The ecology of exploited stocks and effects of stock levels, harvests, bycatch, and conservation measures on the broader ecosystem are explored.

*Facing page: Studies of pelagic ecosystems frequently include surveys of midwater fauna using large trawl nets. Catches are moved into the ship's laboratory for the demanding tasks of sorting and identification.*

Stock assessments are currently conducted for tunas, billfishes, pelagic sharks, bottomfishes and lobsters. These assessments, along with estimates of the bycatch of sea turtles, seabirds, and marine mammals are provided to support informed decisions by the NOAA Fisheries Pacific Islands Regional Office (PIRO), the Western Pacific Regional Fishery Management Council (WPFMC), and international organizations such as the Western and Central Pacific Fisheries Commission (WCPFC), the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), and the Inter-American Tropical Tuna Commission (IATTC).

The FBSAD is organized into three programs:

- *The Fishery Biology and Bycatch Program* focuses on identifying methods to minimize incidental capture of sea turtles and other bycatch species in pelagic longline and other fisheries, including modifications to fishing gear and bait, and promotes adoption of such methods through outreach and education programs. The program also conducts research on habitats, movements, distribution, and post-release survivorship of fishes, sharks and sea turtles released from pelagic fishing gear. Other research is conducted to model the effects of various factors on the vulnerability of pelagic fishes to capture in longline and other fisheries and to use the results in standardizing catch-per-unit-effort (CPUE) data for pelagic stock assessments. Staff in this program also lead the WPFMC Pelagic Fishery Management Plan Team.
- *The Life History Program* conducts basic research on the age, growth, and reproductive strategies of managed fish species and bycatch species. The program also collaborates in studies of coral reef fish community structure and responses of reef fish populations to anthropogenic factors.
- *The Stock Assessment Program* conducts population assessments of pelagic species, including yellowfin and bigeye tuna in the western and central Pacific, albacore in the South Pacific, and swordfish, striped marlin, and blue shark in the North Pacific. Assessments are also produced for insular species including bottomfish in the Hawaiian Archipelago, Guam, and Mariana Archipelago and lobster in the Northwestern Hawaiian Islands. Top priority is given to the multispecies complex of bottomfish in the main Hawaiian Islands, which is subject to excessive fishing pressure. The program estimates incidental takes of sea turtles, seabirds, and marine mammals, and the bycatch of fish species (mostly sharks) in the Hawaii longline fishery. The program also develops and implements international collaborative research agreements with foreign scientific institutions and organizations and provides leadership to the WPFMC Hawaiian Archipelago Ecosystem Team and the Western Pacific Stock Assessment Review process (WPSAR).

In addition to directing research activities of the Division, the FBSAD Chief serves as International Science Advisor to the Directors Office, providing critical support and counsel on scientific issues arising with respect to tunas, billfishes, and ecologically associated species in the Pacific. The International Science Advisor is responsible for: providing scientific advice, technical reports, and informed opinion on scientific matters at meetings of the WCPFC, ISC, and other regional fisheries organizations; providing similar scientific support to PIRO, the U.S. State Department, and other members of official U.S. delegations to such meetings; and leading the U.S. delegation at meetings of the WCPFC Scientific Committee. The International Science Advisor also oversees the compilation of official fishery statistics for U.S. fishing fleets harvesting tunas and billfishes in the Pacific Islands Region, and the submission of such statistics to the WCPFC and other regional field offices.

FBSAD staff provide expertise, advice and leadership within scientific working groups of international fishery organizations including WCPFC and ISC, and in support of multilateral efforts to establish a regional fisheries management organization for the northwest Pacific.

| FBSAD Personnel | |
|---|---|
| Federal | 21 |
| JIMAR | 11 |
| *Total* | 32 |

FBSAD staff members also help the Directors Office in overseeing NOAA Grants to the Oceanic Institute, advise the State of Hawaii on matters related to introduced and invasive species, and organize and maintain the PIFSC schedule of research cruises on the NOAA Ship *Oscar Elton Sette*.

FBSAD has a staff of 32 people including 21 federal employees and 11 employees of JIMAR. Staff salaries and benefits made up the largest share of expenditures in FY 2009.

## Key 2009 Accomplishments

- Completed research on the effects of a gear depth modification in the American Samoa-based longline fishery for use by the WPFMC in developing turtle bycatch mitigation measures.
- Estimated incidental takes of sea turtles, seabirds, and marine mammals in the 2008 Hawaii longline fishery.
- Completed a paper on using productivity and susceptibility indices to determine the vulnerability of managed fish stocks.
- Provided science-based advocacy for sea turtle bycatch reduction methodologies at the 5th Annual Meeting of the WCPFC resulting in the adoption of a Conservation and Management Measure requiring the use of circle hooks or fish bait in shallow-set longline fishing.
- Cochaired and lead the U.S. Delegation to the annual meeting of the WCPFC Scientific Committee; reports are posted on the WCPFC Web site at: http://www.wcpfc.int/.
- Completed U.S. Annual Reports and data submissions to the WCPFC and ISC.
- Convened and chaired meetings of the ISC Billfish Working Group. Meeting reports are posted on the ISC Web site at: http://isc.ac.affrc.go.jp.
- Served as lead of the U.S. Science Delegation to the 4th Scientific Working Group Meeting of the Inter-Governmental Meeting on Management of High Seas Bottom Fisheries in the north western Pacific Ocean, providing expertise on biology and fisheries of the Emperor-Northern Hawaiian Ridge seamounts.
- Provided U.S. longline catch forecast products to PIRO for guiding compliance with bigeye tuna catch limits set by the WCPFC and IATTC in the western and eastern Pacific Oceans, respectively.
- Collaborated in updating stock assessments of bigeye and yellowfin tuna in the western and central Pacific, and albacore in the South Pacific.
- Contributed scientific inputs to the WCPFC, ISC, and WPFMC on a range of topics including status of stocks, CPUE standardization, and bycatch mitigation.
- Published North Pacific blue shark stock assessment.
- Completed and published a collaborative stock assessment of North Pacific swordfish.
- Completed an updated bottomfish stock assessment and Total Allowable Catch risk analysis for MHI bottomfish and provided results to the WPFMC and other stakeholders for their use in setting catch limits.
- Completed a scientific peer review of the bottomfish stock assessment through WPSAR.
- Chaired a workshop on deep slope bottomfish science ecosystem and monitoring.
- Collaborated in a publication on the reproductive ecology and scientific inference of "steepness," a fundamental metric of population dynamics and strategic fisheries management.
- Published a study on methods for age determination of billfishes using fin spine cross sections.
- Discovered a cryptic, second North Pacific species of moonfish (*Lampris*), a large pelagic predator, based on genetic and morphometric analyses.
- Developed cooperative research agreements with Japan's National Research Institute of Far Seas Fisheries for billfish research, and with Shanghai Ocean University on a suite of biological, ecological, and economic research topics.

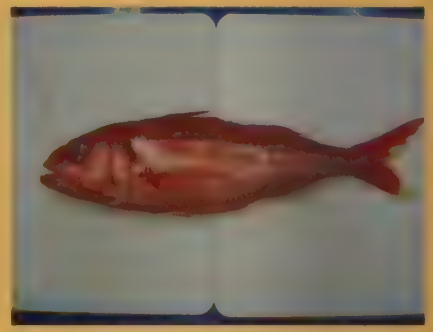
**Fishery Biology and Stock Assessment Division—FY 2009**

| | $ | % |
|---|---|---|
| Salaries and benefits | 2,418,209 | 58.6 |
| Grants | 288,546 | 7.0 |
| Contracts | 849,465 | 20.6 |
| Travel, transportation, charters, printing, supplies, equipment | 567,355 | 13.8 |
| Total | $4,123,575 | |

## Challenges, Problems, and Limitations

Although the Division Chief serves as International Science Advisor for the U.S. delegation to WCPFC and FBSAD staff members contribute significantly to scientific work in support of the WCPFC, ISC, and other regional international fisheries agreements, PIFSC has not received funding to provide such scientific support. The budget for fish bycatch research and for other fish and ecosystem research is very limited. Core fish stock assessment tasks are substantially funded, but mandates to assess additional species and meet new requirements of the Magnuson-Stevens Fishery Conservation and Management Act, particularly establishment of annual catch limits for all fisheries, are underfunded.

Within the Center, challenges remain with developing and coordinating integrated research programs needed to support ecosystem approaches to management of living



*Biological specimens, like this ehu, provide information needed to improve stock assessments and scientific advice for fishery managers.*

marine resources. One of the challenges for FBSAD scientists is to improve stock assessments with a focus through greater use of oceanographic data products developed by EOD.

Among other challenges, FBSAD has been asked to help assess coral reef fisheries and provide scientific advice to the State of Hawaii on management of fisheries in the main Hawaiian Islands through closed areas and other means. Information is often lacking to adequately address these issues, which have traditionally been outside federal jurisdiction.

## Future Focus and Direction

Testing of improved fishing gear to reduce longline bycatch will continue, in collaboration with other nations, with a focus on sea turtles and sharks. Recommendations for international fisheries conservation measures on bycatch, and methods to reduce incidental catches of billfishes in Pacific-wide longline fisheries will be actively promoted. Bycatch work will include completion of a new National Bycatch Report with coverage of all fish species and protected species

New research will be focused on bottomfish life history, distribution, and stock dynamics throughout the US. Pacific Islands, using cooperative research funding, other new funding, and NOAA fisheries research vessels. The feasibility of conducting fishery-independent bottomfish surveys in the region will be explored, and a bottomfish tagging study will be undertaken to assess movements between banks. The Life History Program will develop new capabilities using more advanced techinques, such as lead-radium and carbon-14 age determination, to estimate age and growth of long-lived fishes such as the deep slope bottomfishes. Work will continue on standardizing bottomfish CPUE data to account for previous changes in the fisheries, so that trends in stock abundance over time can be more accurately described and assessments can be improved.

A comprehensive Pacific Islands Fisheries Science Center Plan for Pacific Highly Migratory Species Science will be completed in FY 2010. Review and improvement of stock assessments for tunas, billfishes, and sharks will continue under the auspices of the WCPFC and ISC. Significant effort will be devoted to standardizing and documenting methods of fishery data processing and reporting to meet increasing demands of international agreements for information and advice. Methods for forecasting fish catches using additional sources of near-real time information and more comprehensive modeling and risk assessment will be developed to improve the advice available to managers attempting to comply with annual catch limits.

### *Review of Billfish Ageing Using Fin Spines Indicates Need to Develop Best Practices*

A key requirement of age-structured fish stock assessment is an accurate method to determine the ages of fish in the catch. In billfishes, ageing relies primarily on the analysis of fin spines collected from sampled fish. Identification of temporal periodicity in fin spine growth increments has enabled scientists to judge the relative age of billfish by counting the increments in cross sections of spines. Ageing procedures can be applied to samples of fish to estimate the age-composition of the catch. Age estimates of individual specimens can be used with measurements of body length to construct billfish growth curves. However, researchers in different parts of the world, working independently of each other, have adopted different approaches to fin spine ageing, adding to uncertainty in billfish stock assessments and regional comparisons of stock dynamics.

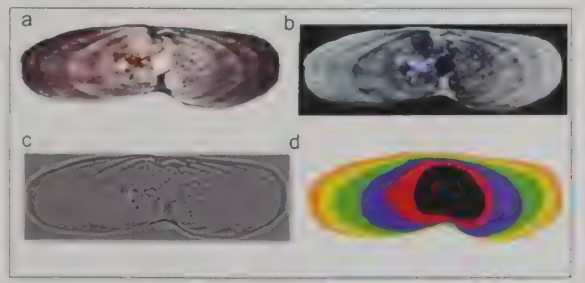
To resolve these differences, a team of billfish experts from PIFSC, University of Miami, and Australia's Charles Sturt University critically reviewed fin spine techniques used by billfish biologists to age the fish, with a focus on age determination in striped marlin (*Kajikia audax*) in the Pacific Ocean and white marlin (*Kajikia albida*) in the Atlantic. The group systematically reviewed the methods used in their research organizations to collect, prepare, and analyze fin spines from these marlin species. They examined an array of topics including fin spine selection; preparation and sectioning of spines; characteristics of annual increments; identification of false increments; measurement of fin spine cross sections; spine vascularization; classification of increments at the edge of the spine section (indicative of most recent growth); assignment of age; and validation of age estimates. Each topic was explored in detail, and strengths and weaknesses of alternative methods were assessed.

Because billfishes in all oceans are highly migratory, they occur in the fisheries of many nations. Differences between nations in the methods used to age billfish may lead to discrepancies in age-composition data used to assess the billfish stocks. Moreover, inconsistencies in ageing methods can make it difficult to determine whether interregional variations in growth estimates are real or just a result of different methodology; resolving such discrepancies is important for accurate stock assess-

Based on their study, the reviewers recommended that a general framework or code of practice be developed to govern age estimation of closely allied billfish species, such as the striped and white marlins. Adoption of common, standardized best practices would enable regional comparisons of growth results and more reliable stock assessment of shared billfish resources.

The collaborative research was published in the peer-reviewed journal Aquatic Living Resources.

Reference: Kopf, R. K., K. Drew, and R. L. Humphreys. 2009. Age estimation of billfishes (*Kajikia* spp.) using fin spine cross-sections: the need for an international code of practice. Aquat. Living. Resourc. 22. [http://dx.doi org/10.1051/alr/2009045].




*Growth increments in striped marlin fin spines can be studied in images of spine cross sections. Increments can be identified, counted, and measured in a normal view (a), inverted view (b), embossed view (c) or digitized view (d).*

# Protected Species Division

The Protected Species Division (PSD) conducts monitoring and research supporting the recovery and sustainability of marine mammals and sea turtles in the Pacific Islands Region. Marine mammal studies involve the highly endangered Hawaiian monk seal population and cetaceans. Marine turtle studies are focused on the threatened Hawaiian green turtle population but also address hawksbill, loggerhead, olive ridley, and leatherback turtles. PSD research covers a broad range of topics in life history, ecology, health and disease, and demography.

The research employs a range of methods including several advanced technologies. Passive acoustic monitoring systems are used to detect underwater sounds produced by cetaceans and by vessels and other anthropogenic sources. Other instruments deployed concurrently record oceanographic features. Satellite-linked Geographic Positioning System tags are attached to monk seals and turtles to track their movements and describe dive patterns. Archival electronic tags are used to obtain fine-scale dive pattern information. Fatty acid profile analysis is used to determine the diet of monk seals. Mathematical and statistical methods are used to model population dynamics and analyze data from field studies and surveys.

| PSD Personnel | |
|---|---|
| Federal | 13 |
| JIMAR | 16 |
| Other | 6 |
| Total | 35 |

*Living page: Studies of shark predation on monk seal pups at French Frigate Shoals include careful observations of mother-pup pairs, like these on Trig Island. High pup mortality is impeding monk seal population recovery.*

The PSD is organized into four programs:

- *The Monk Seal Research Program* conducts research on the Hawaiian monk seal population with the goal of enhancing its recovery. The program's work covers the entire Hawaiian Archipelago and includes an annual census of seal abundance and other field studies to assess population trends and demographics at the main breeding sites in the Northwestern Hawaiian Islands (NWHI) and main Hawaiian Islands (MHI); investigations of foraging ecology; monitoring and assessment of health and disease parameters; identification of natural and human factors that may be limiting monk seal recovery; and research on methods to enhance recovery of the species.
- *The Cetacean Research Program* studies populations of whales and dolphins in the central and western Pacific Ocean and involves a range of topics, including surveys of cetacean distribution, abundance and stock structure; studies of habitat use, reproduction, and mortality; and assessment of natural and anthropogenic threats to cetacean populations. The program's research involves ship-based visual and acoustic line transect surveys, photo-identification studies, passive acoustic surveys using High-Frequency Acoustic Recording Packages (HARPs), habitat modeling, and ecosystem studies.
- *The Marine Turtle Research Program* is responsible for research on the threatened Hawaii green turtle population. The research agenda is comprehensive: field studies of growth rates, mortality, and movements; long-term monitoring of abundance trends, including annual surveys of the primary nesting colony at East Island, French Frigate Shoals, in the NWHI; and the biology, etiology, and effects of fibropapilloma disease. The program trains Pacific islanders and fishery observers in sea turtle biology and handling, collects data on fishery interactions with sea turtles, and studies the pelagic ecology of loggerheads in the Pacific. Many of the program's studies involve partnerships with scientists in other agencies and institutions, both in the U.S. and in foreign countries.
- *The Marine Turtle Assessment Program* (MTAP) expands understanding of marine turtle population ecology through studies of the stock structure and status of turtle populations across the Pacific Ocean. The primary geographic focus of the program is on the U.S.-flagged Pacific territories outside of the Hawaiian Archipelago. Program scientists also collaborate with the Marine Turtle Research Programs at PIFSC and the NOAA Southwest Fisheries Science Center to achieve the wider goal of marine turtle stock recovery in the Pacific basin. Current research projects include: turtle demography and population dynamics; assessment of natural and anthropogenic factors affecting turtle populations; evaluation of management strategies influencing marine turtle recovery; development of statistical simulations to identify data needs and demographic trends and design and evaluate management strategies; development of skeletochronology techniques for aging of stranded turtles; and a variety of other studies of marine turtle population ecology. Recently, the program began working with biologists in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) to help them develop mentoring programs

| Protected Species Division—FY 2009 | $ | % |
|---|---|---|
| Salaries and benefits | [illegible] | [illegible] |
| Grants | [illegible] | [illegible] |
| Contracts | [illegible] | [illegible] |
| Travel, transportation, charters, printing, supplies, equipment | [illegible] | [illegible] |
| Total | [illegible] | |

to assess abundance and stock structure of marine turtle populations in their areas.

The PSD staff of 35 includes 13 federal employees, 16 JIMAR staff, and others. Grants and salaries make up most of PSD expenditures in FY 2009.

## Key 2009 Accomplishments

- Conducted a workshop to review protocols, staffing, priorities, and other elements of the Hawaiian monk seal research program to maximize research productivity and efficiency.
- Fully staffed and conducted annual NWHI monk seal population assessment, including winter camps.
- Conducted cetacean assessment survey in the main Hawaiian Islands, using the NOAA Ship *Oscar Elton Sette* to investigate cetacean abundance and evaluate seasonal movements of cetaceans relative to previous surveys.
- Initiated deworming trials to study the potential for increasing the survival of juvenile monk seals by decreasing their parasite loads.
- Completed field collections of Hawaiian monk seal health and disease information in the NWHI.
- Conducted a workshop of monk seal researchers, shark experts, and key stakeholders to discuss and develop strategies for mitigating shark-related mortality of young monk seals at French Frigate Shoals.
- Estimated the number of green turtles nesting at East Island, French Frigate Shoals, during the 2009 nesting season.
- Successfully relocated 6 weaned monk seal pups from French Frigate Shoals to Nihoa Island with the objective of improving their chances of survival.
- Conducted cetacean surveys off the west coast of Oahu, attaching satellite tags to false killer whales to evaluate their movement patterns relative to prey resources and commercial fishing.
- Worked with the ITS Systems Design Team to convert the marine turtle database from Microsoft Access to Oracle and checked the quality of historic data.
- Began a study of organochlorine and other contaminants in Hawaiian monk seals of the main Hawaiian Islands.
- Continued long-term acoustic monitoring of cetaceans at Palmyra Atoll, Ladd Seamount, and the Island of Hawaii, and began an evaluation of acoustic survey records in the Northwestern Hawaiian Islands to identify oceanographic correlates of cetacean seasonal occurrence.
- Published a paper on historic changes in the dietary preferences of Hawaiian green sea turtles in Kaneohe Bay, Oahu.
- Released 25 satellite-tagged juvenile loggerhead turtles in pelagic waters of the North Pacific to study their ecology, movements and habitat use in collaboration with international partners and EOD staff.
- Completed a 2-year study to identify deterrent devices effective in the mitigation of shark predation on Hawaiian monk seal pups at French Frigate Shoals.

*PIFSC research extends into the Mediterranean Sea, where studies are underway to develop modifications of fishing gear and practices that reduce incidental capture and mortality of sea turtles.*

## Challenges, Problems, and Limitations

Our comprehensive monitoring of Hawaiian monk seals in the NWHI continues to document a persistent decline in this imperiled species. An ongoing challenge is to diagnose the root causes of the population decline and develop tools and strategies for enhancing the species' recovery. In the cetacean and sea turtle programs, we have broadened research agendas and identified research priorities, but lack adequate funding and other resources to carry out new mandates.

## Future Focus and Direction

During 2010, we will continue to emphasize studies of the ecological factors influencing the decline of Hawaiian monk seals, in part by studying the habitat needs and foraging

behavior of juvenile seals. Concurrently, we will build partnerships with other agencies and nongovernmental organizations to develop methods for increasing the survival of juvenile seals. We will continue field camps in the NWHI to collect demographic data for long-term monitoring, collect specimens for studies of seal foraging and health, and mitigate seal mortality (e.g., by disentangling seals from debris and reducing shark predation). PSD also will expand monk seal monitoring and assessment in the MHI, where seal abundance is increasing and human contact with seals is becoming more frequent.

PSD will further develop and implement the cetacean stock assessment research program in 2010. The cetacean program will begin research in waters of CNMI, Guam, and Wake Island with ship-based sighting and acoustic surveys, the placement of HARPs for year-round assessment of cetacean occurrence, and new partnerships with local agencies to build cetacean research capabilities in those areas. We will expand the community-based photographic identification catalog for Hawaiian spinner dolphins and initiate research on false killer whales and their interactions with longline gear with the goal of reducing and mitigating incidental take of this species by the fishery.

PSD scientists will continue research on the foraging ecology of Hawaiian green sea turtles, place increased emphasis on study of the endangered hawksbill sea turtle, and address stock assessments of marine turtles in Hawaii, American Samoa, Guam, and the CNMI. PSD will also continue to assess the status of marine turtle populations that forage in the central North Pacific but nest outside the United States, including leatherbacks, loggerheads, and olive ridleys.

## *Endangered Hawaiian Monk Seals Exhibit Extremely Low Genetic Diversity*

Recent research by scientists from the University of Hawaii's Hawaii Institute of Marine Biology (HIMB) and the Pacific Islands Fisheries Science Center (PIFSC) revealed that Hawaiian monk seals, like many other endangered animal populations, have low genetic diversity. But the extremely low level of diversity discovered in monk seals is unprecedented. The findings are based on genetic screening of almost every monk seal encountered during beach surveys by PIFSC biologists over the past quarter century — more than 2400 animals. Small plugs of tissue were collected from the flippers of 2355 seals in the Northwestern Hawaiian Islands and 54 seals from the main Hawaiian Islands. Genomic DNA was extracted from the samples and analyzed by HIMB.

Genetic diversity is an asset to wildlife populations. Species with a rich store of genetic resources are better able to face adversity, whereas those with low genetic variation are less able to fend off disease and adapt to changes in their environment. Moreover, all populations, but especially those with low genetic diversity, are more vulnerable when they are small. Hawaiian monk seals number about 1200 and the population is declining at 4.5% annually due to low survival of pups and other factors. Accordingly, the question of the population's genetic diversity has drawn considerable attention.

The cause of low genetic diversity in monk seals remains unknown. Research by other scientists has shown that a "bottleneck" of low genetic variability can result in a population rapidly reduced to low numbers, as Hawaiian monk seals were when hunted by European explorers in the 1800s. Other factors, like inbreeding, can also reduce genetic variation. But the recent Hawaiian study indicates that the low genetic variation in monk seals predated the 19th century human impacts and there is scarce evidence of inbreeding in today's population.

Despite its extraordinarily low genetic diversity, the monk seal population has shown a capacity to grow if conditions permit, as it apparently recovered to some degree during much of the 20th century. Its recent steady decline is attributed to food limitation, shark predation, entanglement in marine debris, and other nongenetic factors. If the population continues to decline, low genetic diversity may become a more critical factor in the species' survival.

The monk seal genetics research was published in the peer-reviewed Journal of Heredity in an article by Jennifer Schultz, Robert Toonen, and Brian Bowen of HIMB and Jason Baker of PIFSC.

Reference: Schultz, J.K., J.D. Baker, R.J. Toonen, and B.W. Bowen. 2009. Extremely low genetic diversity in the endangered Hawaiian monk seal (*Monachus schauinslandi*). J. Hered. 100(1):25–33. http://dx.doi.org/10.1093/jhered/esn077.

# Notable Milestones

- ❒ Conducted an external panel review of the Center's pelagic research activities
- ❒ Convened a workshop to establish a Center vision and strategy for climate research
- ❒ Ensured Center compliance with the National Environmental Policy Act
- ❒ Ensured Center compliance with the NOAA small boat safety program
- ❒ Developed and implemented a database and online reporting system for Hawaii noncommercial bottomfish fishers
- ❒ Completed a comprehensive operations manual for the Center's library
- ❒ Completed a manuscript on modification of longline fishing practices to reduce bycatch
- ❒ Led the U.S. delegation at the 4th Scientific Working Group Meeting in support of the Inter-governmental Meeting on Management of High Seas Bottom Fisheries in the North Western Pacific Ocean
- ❒ Led the U.S. delegation at the annual meeting of the North Pacific Marine Science Organization
- ❒ Convened meetings of the Billfish Working Group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
- ❒ Completed an updated stock assessment of swordfish in the North Pacific
- ❒ Completed an updated stock assessment of bottomfish in the Hawaiian Archipelago
- ❒ Estimated the bycatch of sea turtles and other protected species in the Hawaii longline fishery for 2008
- ❒ Projected the carrying capacity of French Frigate Shoals for Hawaiian monk seals using an updated ECOPATH model
- ❒ Published an article describing recent changes in the species composition in upper trophic levels of the central North Pacific subtropical gyre ecosystem
- ❒ Expanded public awareness of the conservation benefits of using barbless circle hooks in Hawaii shoreline fisheries
- ❒ Prepared and disseminated quarterly and annual reports of catch and effort statistics for the Hawaii- and American Samoa-based pelagic longline fisheries
- ❒ Completed and published a report on the dynamics of the Hawaii bottomfish market
- ❒ Chaired a workshop session on catch and effort in traditional fisheries of American Samoa
- ❒ Completed the 2008 Hawaiian monk seal stock assessment analysis and report
- ❒ Developed a plan for systematic surveys of the main Hawaiian Islands monk seal population
- ❒ Completed an integrated Center-wide sea turtle research plan
- ❒ Published a research paper on the dietary shift of Hawaiian green turtles in Kaneohe Bay, Oahu
- ❒ Completed a manuscript on strandings of hawksbill turtles in the Hawaiian Islands
- ❒ Completed a manuscript on the Coral Reef Ecosystem Integrated Observing System
- ❒ Conducted Pacific Reef Assessment and Monitoring Program research surveys in the Northwestern Hawaiian Islands, main Hawaiian Islands, Wake Atoll, and the Mariana Archipelago

oral Reefs
DEEP-SEA RESEARCH
PART I
Ecological
Ecological
ECOLOGY
Fisheries Research
FISHERIES SCIENCE

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